United States
Department of
Agriculture

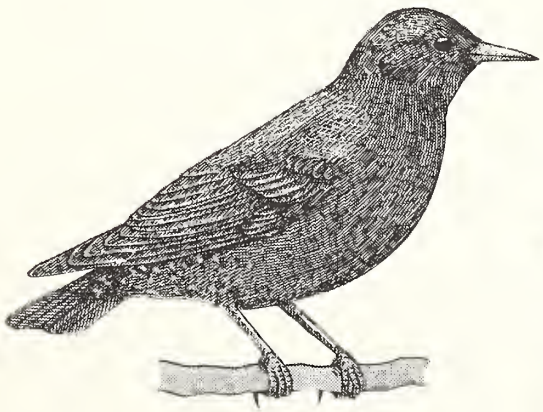
Forest Service

September 1983

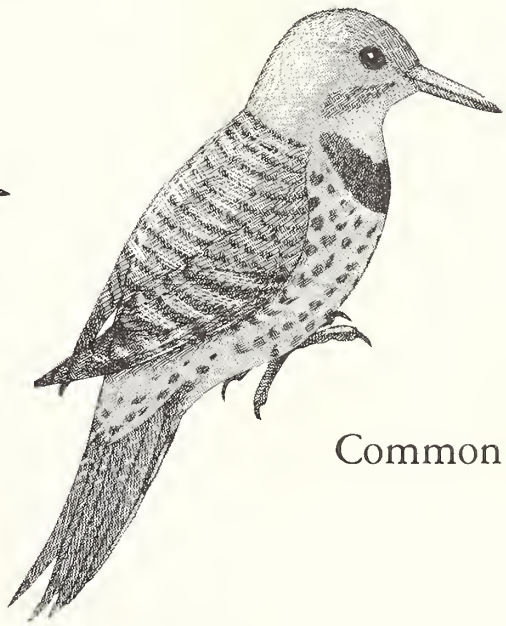
Forestry Research West

American Kestrel

Screech Owl



Starling



Common Flicker

A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

Forestry Research West

In This Issue

Cover

Research wildlife biologists at the Pacific Southwest Station believe that a new approach—inventorying everything in a wildlife guild (a group of species that exploits the same class of environmental resources in a similar way)—might be a more efficient and less costly way of evaluating wildlife and wildlife habitat. The birds on the front cover are just a few of the many being studied. Read more about it on page 1.

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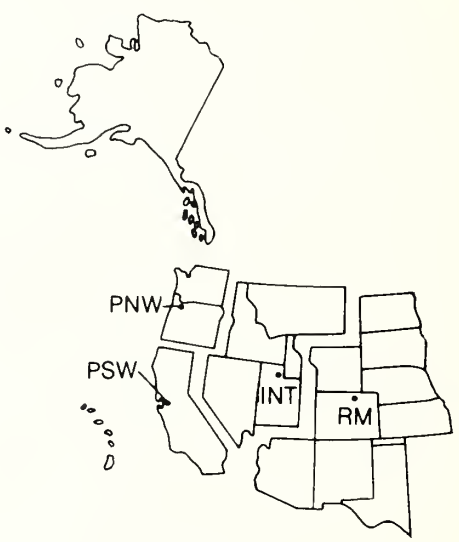
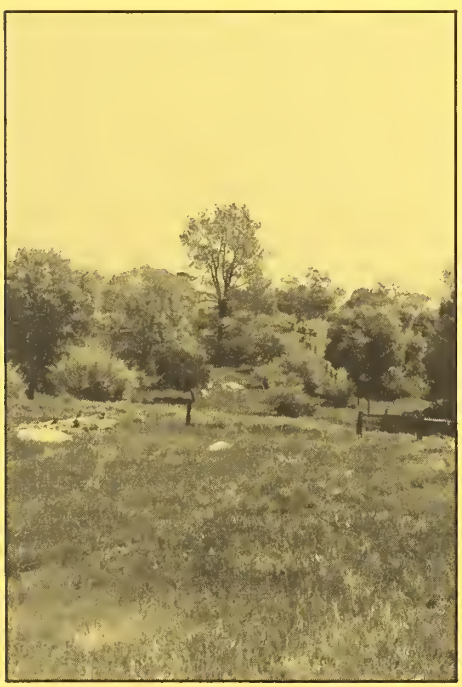


Monitoring wildlife by whole-guild inventories

by Dennis G. Hanson

Dennis G. Hanson is a free-lance writer who specializes in natural resources. He lives in Sebastopol, California.



The guild-unit approach was studied on the San Joaquin Experimental Range, Madera County, California. The plots were mature woodlands of mixed stands of blue oak, interior live oak, and digger pine, with a shrub layer of Buck brush, and ground cover of annual grasses and forbs.

The National Forest Management Act of 1976 (NFMA) requires that all wildlife resources on National Forests be monitored by means that are not only comprehensive but also biologically and statistically sound.

Attempting to met the NFMA requirements by classical methods of sampling animal populations, coupled with standard methods of statistical analysis, would be prohibitively expensive.

Jared Verner, research wildlife biologist at the PSW Station, believes that a new approach—inventorying everything in a wildlife guild—"a group of species that exploits the same class of environmental resources in a similar way"—might be a more efficient and less costly way of evaluating wildlife and wildlife habitat.

The very term itself, "guild," has odd beginnings. In Anglo-Saxon days, a "gild" was a penitent offering, a protection against the future. A few centuries later, medieval merchants and tradesmen foresaw their own needs for collective protection. Binding themselves together with common wants and goals, their "guilds" were forerunners of today's trade unions.

Here the term is used to denote the ecological mergers that biologists apply to nature's world of common interests, a group of plants or animals that somehow have an ecological kindredship and similar mode of life.

Depending on what is needed, wildlife researchers can define a guild to their own investigative liking. For instance, in one study the species may be foliage-gleaning insects, because they use a similar food in a shared environment. Other studies may have species that have diet or breeding similarities in a certain ecosystem, such as the shrub layer in a woodland ecosystem.

The indicator-species method is perhaps the most widely used method of guild research today. The conjecture is that since all members of a certain guild use the same resources—air, water, food, breeding space, nesting area—all should respond similarly to certain changes in their environment. In other words, pick a certain bird in a given guild and it can theoretically tell the researcher what's happening with the rest of the creatures in that same habitat. If its status changes for better or worse, there should be good scientific reason that the status of the entire guild is similarly changing.

A whole-guild approach

For a multitude of reasons, Verner, who is in charge of the Pacific Southwest Station's research on Protection and Management of Sensitive Species in California, thinks that a whole-guild approach to define habitat capability to support wildlife populations could prove much more efficient—and money saving—than the use of single indicators. It would look at all the species in a given guild.

One support for his approach is that guilds can be grouped in a number of ways, depending on management needs, such as all species that use a particular environment for breeding, or all species that depend on tree canopies for foraging, or use tree boles for nesting.

There are other advantages. "When using the indicator-species method," said Verner, "you can't get a high count of all the species in that particular environment. You also have

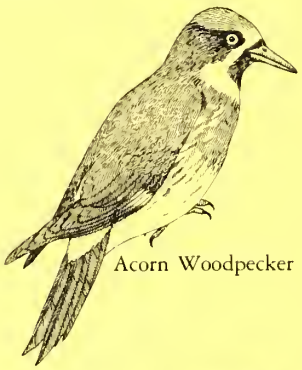
to assume, perhaps falsely, that the species you pick is a true indicator for the area."

For example, if one were using the indicator method to study a certain riparian area, the red-tailed hawk might be selected as the keystone to determine the health of the habitat. As the red-tailed hawk went, so, one might extrapolate, went the health of that habitat. But is it certain that the red-tailed hawk is the best indicator of the health of that area? Regardless of what happens to the hawk's population, are there other, more subtle elements that impact the vitality of the riparian zone?

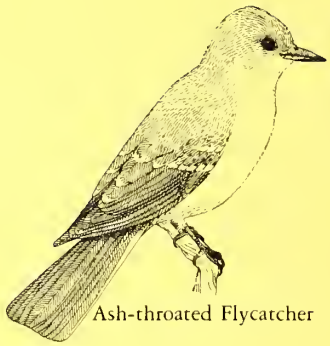
"If a guild includes bark and canopy feeders, all species should respond similarly to timber harvest, but not necessarily to a fire. The timber harvest would generally lower population levels of species dependent upon trees, either the canopies or the boles. But a fire of moderate intensity might reduce tree canopy without markedly diminishing the bark surface. So, at least for a short time, canopy feeders could be eliminated by a fire when bark feeders were not," Verner said.

One must also be careful about the way guilds are composed says Verner. For example, "the roadrunner, a ground feeder in arid shrublands of the Southwest, is an unlikely guild companion with the wood ibis, a swamp-dwelling species of the southern states that feeds in shallow freshwater ponds and sloughs. In one guild, gleaners of insects in trees and shrubs were combined, but some environmental changes effect the shrub and tree layers differently."

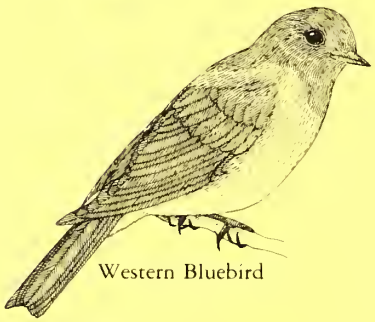
Guild cell from matrix for canopy feeders: (clockwise, top left) Acorn woodpecker (ACWO), Ash-throated flycatcher (ATFL), Plain titmouse (PLTI), Western bluebird (WEBL). Four-letter legend in parentheses identifies species on matrix.



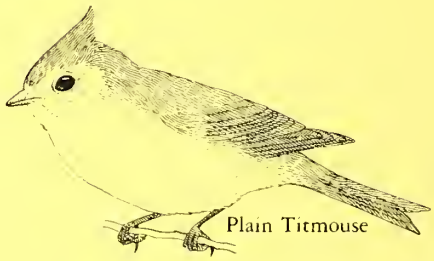
Acorn Woodpecker



Ash-throated Flycatcher



Western Bluebird



Plain Titmouse

Saving dollars

Another advantage for the whole-guild approach may be cost. Using the indicator method, the number of species counts needed to detect meaningful annual differences can be both prohibitively large and expensive, even for common species. For example, with an average of one bird per count, one needs 12,300 counts to detect a 10 percent difference in abundance of that species between years. In one such case that Verner cites as an example, the salary alone for entry-level technicians to do the job would be $33,840 per year.

Verner's whole-guild proposal, which would count all species in any guild, is a fresh approach. "There has been some research, and a lot of us have thought about it for a long time," said Verner, "but it's never actually been applied."

By counting everything in the defined guild, the approach reduces the possibility of losing a species from the area. It would also permit a researcher to look separately at any trends among permanent residents, winter residents, migrant breeders, and spring or fall residents. For instance, if timber

American Kestrel

PSW
Guild cell from matrix for ground feeders: (clockwise, top left) American kestrel (AMKE), Screech owl (SCOW), Common flicker (COFL), Starling (STAR). Four letter legend in parentheses identifies species on matrix.

Screech Owl

Starling

Common Flicker

harvesting or a hard winter wipes out a resident breeder, it would show up in the whole-guild evaluation. It might not, however, if only one indicator bird was being examined. Looking at all species within a given area might also give a researcher a feel for whether changes were due to habitat impact or something else.

At present, officials of the Sierra National Forest in California are gearing up to use the whole-guild approach in their land-management programs, particularly in three major habitat areas—riparian, meadow-edge, and late successional mixed conifer.

The plan for monitoring wildlife resources was recommended by the Interdisciplinary Planning Team of the Sierra National Forest. Verner considers the plan as reasonable and realistic. "It recognizes the need to provide a biologically sensible and statistically sound system that is cost-effective," Verner said.

The plan calls for integrated monitoring at three levels: 1) Species—only those management indicator species required by law; 2) Management guilds—guilds of birds in three habitats especially vulnerable to change by human activities; and 3) Habitats—most wildlife species will be monitored by inference from trends in habitats, based on knowledge of each species' habitat requirements.

"The use of this plan by the Sierra National Forest gives us an opportunity to test the system," said Verner, "to see if it gives us the answers we're after, as well as whether it saves money."

Even though Verner calls the plan "sensible and reasonable," he says it may be far from the system that will eventually emerge as an accepted standard for all National Forests.

"Other Forests will try other systems, and rightly so," he says, "all systems should be studied carefully to learn how well they meet the intent of NFMA, and all should have the flexibility to allow changes that promise to improve the quality of monitoring wildlife resources, at lower costs but without sacrificing quality."

The system is planned for a gradual phase-in by the Sierra National Forest. "They are already choosing the meadow-edge sites," said Verner. Sample results from that area study may not be seen for a year, while, at the same time, the other two study areas are being developed.

"It takes time," said Verner. "At least 200 sites in each of the three types must be chosen, marked, and documented. Even if it's being done full-time, it can take a full season just to locate the right sites in any

habitat area." After the study sites are picked, the research design has to be set—what time of day to observe, months and seasons of the year, and groups of species to be defined as a guild.

Any chosen site is a single point where a trained observer may spend 5 to 10 minutes. "Tests will have to determine what the optimum length of time is, as well as the daily number of observations," said Verner. The observations will be done by entry-level biological technicians or perhaps a staff of volunteers. "They'll have to be screened to make sure they can identify the species," he said.

"There are problems with any new methodology," said Verner, and, like all science that is dependent on mortal input, the greatest plague to whole-guild inventories may be human variability. "Potentially, there are substantial differences between the people doing the observation," said Verner.

To be meaningful, a whole-guild inventory must be made consistently day after day over a lengthy period of time. Verner cites a conceivable instance: "Suppose you had an extremely skilled graduate student in 1984, one who really knew the species. After a year, he goes on to another job and is replaced by someone else who is maybe not so skilled. The species count, obviously, is going to go down." The answer probably rests with charging several observers with maintenance of a whole-guild inventory, which would, at best, provide an average record.

Human logistics notwithstanding, forestry researchers will be watching for the scientific results of the California whole-guild study, as well as, in these days of budget restraints, for its cost implications.

PRIMARY FEEDING ZONE	Ground	Shrubs	Tree boles and limbs	Tree canopies	Snags	Breeds elsewhere
Snags			VGSW			
Tree canopies			ACWO ATFL PLTI WEBL	COHA ANHU WEKI BGGN PHAI HUVI NOOR		SSHA BTPI YRWA DEJU
Tree boles and limbs			NUWO WBNU			YBSA
Shrubs		WREN CATH	HOWR BEWR	BUSH		HETH RCKI WCSP FOSP LISP
Ground	TUVU CAQU CORA WEME RCSP	ROAD BHCO LEGO BRTO	AMKE SCOW COFL STAR	RTHA MODO GHOW LEOW SCJA HOFI		AMRO RSTO GCSP

PRIMARY NESTING ZONE

The matrix approach to guild delineation provides flexibility. As shown here, the 51 species represented in counts at the San Joaquin Experimental Range could be represented by 15 guilds, if each cell of the matrix is used to delineate a guild. On the other hand, all species in any row or column of the matrix can be lumped into larger guilds. In this way, you can identify five potential guilds defined by feeding zone or six defined by nesting zone.

Experiment at San Antonio Mountain

by Rick Fletcher
Rocky Mountain Station

Although forest meteorology has traditionally been tied to fire control, significance of the science is rapidly expanding into the fields of air resource management, reforestation, logging, engineering, recreation, and insect and disease control.

Unfortunately, resource specialists often do not have representative meteorological data to work with. This is especially true in mountainous terrain, where data are limited due to the rugged, complex geography—making the set up and monitoring of meteorological instruments difficult.

Scientists at the Rocky Mountain Station are working on a 5-year experiment, begun in 1980 on San Antonio Mountain in north-central New Mexico, aimed at understanding the effects of elevation and aspect on temperature, relative humidity, wind direction, windspeed, and precipitation.

The San Antonio Mountain Experiment (SAMEX) is being carried out on a 3,325-meter-high, conically shaped, isolated mountain. This mountain was selected because it provides all aspects; nearly uniform slopes; a variety of vegetation-grass, brush, and trees; and access road to the peak; and is on the Carson National Forest, a location which minimizes administrative concerns.

Nine remote automatic weather stations (RAWS) are located at various elevations and aspects on the mountain, and take hourly measurements of wind direction and speed, air temperature, relative humidity, and precipitation. (The station at the peak also measures barometric pressure).

A new approach

Morris McCutchan, research meteorologist who designed and manages the SAMEX project, says, "Many investigators have studied the effect of elevation and aspect on meteorological variables. However, none have studied all the meteorological variables together at different elevations and aspects, as this study is doing, nor has anyone been able to isolate components of elevation and aspect in a configuration sufficiently simple to lead to widely useable results."

In addition to the RAWS, scientists are using tethered and free-flying balloons, together with mathematical models, to help provide flexibility to examine meteorological variations in response to both local and larger-scale changes.

What does this mean to resource specialists? Doug Fox, Project Leader for the Forest Meteorology and Air Quality Work Unit in Fort Collins, says, "Computer models and other knowledge resulting from this research will have three immediate applications."

Looking south at San Antonio Mountain.

1) Wildland fire agencies maintain a network of more than 800 manned fire-weather observation stations in the United States. Observations are taken once each day in the early afternoon (1300-1400 local time) when fire danger is usually the highest. The stations are located in the open and, where possible, have a southerly or westerly exposure. Results from this research will help develop computer models that will be able to extrapolate these data to other times of the day and to areas with different elevations and aspects.
2) The USDA Forest Service and other resource agencies currently maintain over 200 RAWS that provide hourly data. Their number is expected to grow rapidly over the next few years, but it is anticipated they will not be located close together because of costs. Because results of research at San Antonio Mountain will help meteorologists understand the effect of elevation and aspect on meteorological variables, scientists can develop computer models that will extrapolate meteorological data to specific operational sites.
3) It is important to locate RAWS in the most appropriate places. Proven techniques for determining the optimum placement of weather stations in mountainous terrain are not available. SAMEX results will help provide the correlation of elevation and aspect to temperature, humidity and wind—necessary to help specialists determine the optimum placement of RAWS in complex mountainous terrain.

The San Antonio Mountain Experiment provides a unique opportunity to isolate the effects of topography on meteorological variables. Resource specialists should look for several improved meteorological computer models to come out of SAMEX.

Meteorological Technician Michael Gilbert prepares to descend a weather station tower after checking operation of wind sensors.

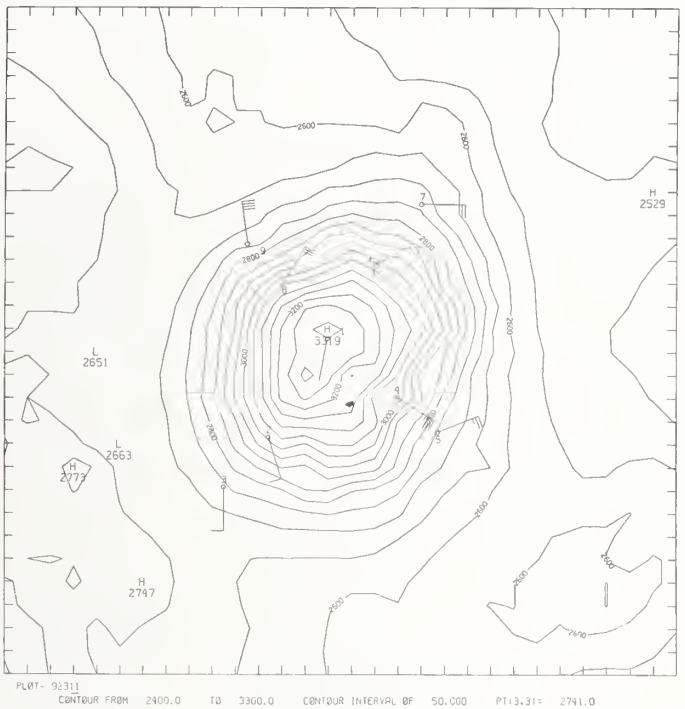


Figure 1.

The effect of elevation and aspect on wind direction and speed is shown on a computer plot of San Antonio Mountain. Figure 1 is a plot for 12 noon on September 23, 1981, and shows the winds blowing upslope at all the stations except the peak, where the wind is light and variable. For example, the wind at station 4 is 135 degrees at 3.5 meters/second, whereas the wind at Station 9 is 350 degrees at 4 meters/second. The winds generally switch after sunset and blow downslope at night, as shown by Figure 2 - the plot for 2 a.m. on September 18, 1981.

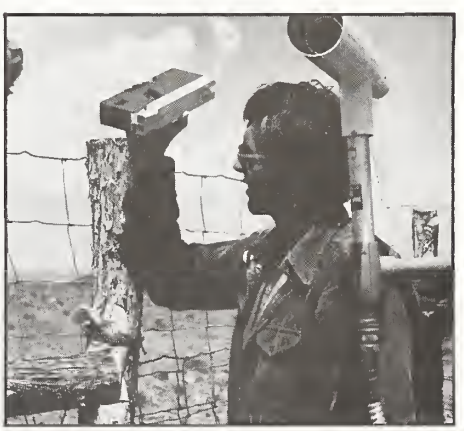
If you would like additional information on this research, write the Rocky Mountain Station and request *San Antonio Mountain Experiment (SAMEX),* a reprint from the *Bulletin of the American Meteorological Society,* Vol. 63, No. 10, October 1982.

For the latest on fire and mountain meteorology, contact the American Meteorological Society and ask for Preprint Volumes for the *Second Conference on Mountain Meteorology,* and the *Seventh Conference - Fire and Forest Meteorology.* Write:

American Meteorological Society
45 Beacon Street
Boston, Massachusetts 02108
(617) 227-2425

Figure 2.

Gilbert uses a portable psychrometer to obtain temperature and humidity readings at one of the weather stations. This "ground check" will confirm the operation and accuracy of the larger temperature and humidity sensor (top foreground).



Researchers optimistic about control of laminated root rot

by Sam Frear
Pacific Northwest Station

A practical method may be on its way to control laminated root rot caused by the fungus *Phellinus weirii* that plagues most kinds of coniferous or evergreen trees in the Pacific Northwest. Scientists at the Pacific Northwest Station have successfully eliminated the fungus from infected stumps in controlled research tests.

Laminated root rot, which usually affects trees in small clumps of an acre or less, causes annual losses averaging about 157 million cubic feet in the northwestern United States and western Canada. In Oregon and Washington alone, researchers believe that about five percent of Douglas-fir forests are infected, meaning about 800,000 acres are, to some degree, out of production.

The disease is particularly active in stands of Douglas-fir and grand fir. A tree's roots are slowly killed, denying it water and nutrients, and weakening its anchorage. Growth loss is common before the tree dies or falls down.

What makes *Phellinus* so pernicious is that the pathogen remains on the site long after an infected tree has been cut down and removed. The fungus may survive there for decades, and succeeding generations of trees may become infected when their roots touch the infected roots of long-dead host trees. Planted trees may then continue the disease on the site.

"The fact that the disease is there means there will be a change in the product," said Walter G. Thies, pathologist for the Pacific Northwest Station at Corvallis. "The quality of the tree's wood may be affected in seemingly small ways that overall are significant, such as more and larger knots in lumber."

In addition, trees infected with *Phellinus* are often attacked by other pests such as bark beetles.

Successful treatment

Thies and fellow Pathologist E.E. Nelson have found a way to kill the fungus in dead, infested stumps. They reasoned that decayed wood, characteristic of the disease, was continuous from the stump top to infected portions of the root system, forming a duct-like system. They drilled holes in stumps and poured in several chemicals, including Chloropicrin, allyl alcohol, Vampam, and Vorlex. The stumps were carefully covered with roofing cement and fiber glass cloth. After a year, when the treated stumps were dug up and examined, the fungus was gone from all stumps and nearly all root systems.

Some of the questions that arise now that some success has been achieved are: How much or how little treatment is necessary? What ecological conditions affect treatment? Do all species respond alike? Does the age of a tree make a difference? Does effective treatment depend on season of the year? Can this stump treatment be made practical for field use? Will it be economical?

Years and years of patient testing and retesting are now required, partly because trees are long-lived and may not show disease symptoms for a decade or more. Nelson and Thies are now working to determine the minimum chemical dosage to kill the fungus, the necessity of covering the stump after treatment, the effect of stump size on effectiveness of treatment, and how soon after treatment an area will be safe for reforestation.

The Nelson and Thies study area west of Portland, Oregon is also the

This is why phellinus weirii is called laminated rot

site for their experiments to see if chemical treatment can save infected live trees. They selected a variety of trees of varying size and varying degrees of obvious infection in the study area. Holes were drilled in the base just past the tree's center. One of two chemicals, Chloropicrin or methylisothiosyanate, was poured in and the holes plugged. After treatment, the scientists wait. If a tree dies, its roots will be pulled from the ground and examined for evidence of root rot. If a tree remains alive for five years, it will be harvested and its root systems examined to see if the pathogen has been eliminated.

Optimism

The two Forest Service scientists are optimistic that the pathogen can be killed this way, but treatment methods must be refined. "We will eventually learn what is the least amount of chemicals to inject into a tree to kill the fungus without adversely affecting the health of the tree," Nelson said. So far, no tree has died from the dosages, and that is encouraging.

If Nelson and Thies are successful in their quest to control *Phellinus weirii,* it will be welcome news to forest managers in the northwestern United States and western Canada. There currently are no quick or easy control options available. The only real option for many managers is to accept the inevitable losses or to grow a less susceptible tree.

Both Pathologist James Hadfield and Silviculturist Ralph Jaszkowski of the Pacific Northwest Region of the Forest Service, forsee that losses from *Phellinus* will increase considerably in the next several decades, not only because of the increase in the quantity of young growth but also because certain cultural practices tend to increase damage by laminated root rot.

The currently recommended control is to cut all susceptible trees in infection centers as well as a buffer area around each. The manager then can mechanically remove stumps and roots and replant with susceptible species, or leave stumps and replant with immune, resistant, or tolerant species. This not only can be an expensive control method, but it too often has been ineffective in controlling the spread of *Phellinus.*

The need for more effective control measures gives significance to the methods being investigated by Nelson and Thies. These scientists stress, however, that it may never be practical to use their treatment systems for forest management. "It probably will be useful in places where trees have a greater value than as timber," Nelson said, "such as in campgrounds, parks, or in residential areas. If we can reduce dosages and streamline application techniques, the treatment may also be used in general forest management."

Nelson and Thies have concentrated on *Phellinus weirii* for only 8 years. They began research by investigating the pulling out of infested stumps to clear an area for planting. They then moved into chemical control. As more of their research

Evidence of laminated root rot also is a red stain in the tree

After holes are drilled in a live tree, chemicals are poured in to see if the pathogen Phellinus weirii can be eliminated

is completed, control of the disease looks possible.

Hadfield hopes so. He has a wish list for future gains on *Phellinus weirii.* He wants enough data on the rate of spread and rate of damage to permit development of a computer model to allow foresters to simulate effects of the disease. He would like to know more about the ecology of the disease, and why is it more severe in some areas than others. And he hopes Nelson and Thies perfect their chemical control work to make it a feasible option for forest managers.

For further information the following publication are available:
1) *Laminated Root Rot Control of Western Conifers,* Forest Insect and Disease Leaflet 159. Washington, D.C.: U.S. Department of Agriculture, 1981
2)*Chemical and Biological Means of Reducing Laminated Root Rot Inoculum,* by E.E. Nelson and W.G. Thies. In: Shaw, G.C., III, comp. Proceedings, 29th Annual Forest Disease Work Conference; 1981, September; Vernon, B.C. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region, 1981.

Pathologist Earl Nelson pours spores of a fungus into a stump to test its antagonism to phellinus weirri.

The liquidator of lodgepole pine

by Delpha Noble
Intermountain Station

The tiny black bug makes no sound as it moves through the trees, but it is relentlessly strangling the lodgepole pine forests of the West. Instead of being evergreen, staggering numbers of lodgepole pines are a pallid red that gives the mountain slopes a burnished hue. The mountain pine beetle has done its work—drilling into the trees and strangling them with the help of the fungus it carries.

Lodgepole pine forests provide important cover on some 63 million acres in the western United States and Canada. These forests contribute to the scenic quality of many landscapes, provide watershed protection, wildlife habitat, grazing for domestic livestock, and raw materials for lumber products.

The mountain pine beetle infests extensive areas of lodgepole pine and probably has done so almost as long as there have been lodgepole pine trees. Beetles also kill ponderosa pine, another important timber source. Historically, the insect kills millions of trees each year in the United States and Canada. During epidemics, a single National Forest may lose more than a million trees in a single year. More than 3 million lodgepole pines were killed on the Targhee National Forest, Idaho, in 1976.

Obtaining an increment core to determine growth response of ponderosa pine following thinning operation to reduce losses to mountain pine beetle.

When beetle numbers are relatively small, the quarter-inch black insect and lodgepole trees coexist rather peacefully. But when enough trees are the right age and size, insect numbers increase. They cause major problems every 20 to 40 years, depending on stand conditions.

Holding beetle populations to a level compatible with productive lodgepole pine stands is a research and management problem. For more than 2 decades, the Intermountain West has been the scene of a strong cooperative program conducted by the Intermountain Station and three National Forest Regions: Northern, Rocky Mountain, and Intermountain. In the laboratory and in the field, research entomologists and forest managers have sprayed, trapped, counted, and reared the beetles, and have harvested some lodgepole stands to learn how to live with the undesirable tenant.

Walter Cole, project leader of the research work unit at the Intermountain Station concerned with mountain pine beetle research, says, "The mountain pine beetle is the prime insect affecting the lodgepole pine ecosystem. It has been called 'public enemy number one.' The effects of infestations change the lodgepole pine environment, and largely determine the nature of forest succession. Unchecked, infestations can expand with each new beetle generation, and even-

tually large areas suffer extreme losses of forest cover."

Cole says this may or may not be a catastrophic situation, depending on landowner objectives. Some landowners, for example, favor grassland over timberland and a bark beetle outbreak may not be a disaster to them. On the other hand, the value of a mountain cabin might be severely reduced by the death of high-value shade trees. From the timber-producer standpoint, the beetle can disrupt management plans and cause an adverse impact on local, regional, and national economies.

The beetle at work

Mountain pine beetles sometimes attack individual, scattered trees, but more often entire groups of trees are killed. The pines the beetle finds most tasty are those over 80 years old and particularly between 120 and 130 years. The insect prefers those with trunks more than 8 inches in diameter.

In July and August the insect finds its favorite lodgepole and ponderosa pines and bores into the moist and tender inner bark (phloem). Phloem thickness is very important to the beetles. If it is thicker than one-tenth inch, beetles can increase in number enough to kill several trees. In thinner phloem, they do not thrive, and populations usually decrease.

After mating, the female beetle lays pearly-white eggs. These hatch within a week or so, and the white larvae start boring through the tree's inner bark, eating and maturing. The adults then bore out, emerge, fly, mate—and the cycle starts again.

The female beetle is a heartless creature. Should a male beetle stay in the gallery, he brushes boring dust (chewed away by the female as she tunnels) out of or into the bottom of the gallery. The boring dust plug packed in the gallery entrance probably prevents other beetles and enemies from entering. If a male gets in the female's way, she kills him and packs him with the boring dust into the bottom of the gallery. (So much for helping around the house!)

The beetle also carries the blue stain fungus, which gets its name from the color it tints the sapwood. The fungus disrupts the water transport system of the tree, thus strangling it to death. The needles at the top and other extremities of the tree dry, turned red, and eventually drop, leaving a gray hulk.

When a tree is attacked by many beetles, pitch ceases to flow from holes where beetles have entered the bark, ensuring successful beetle reproduction. Evidence of infestation usually consists of pitch tubes and boring dust in bark crevices and at the base of the tree. Although pitch tubes may be absent or small, orange-brown dust at the pine base is a sure sign that the tree has been invaded by enough beetles to kill it.

What is the risk?

How does a manager determine if a lodgepole pine stand is susceptible to a beetle invasion?

Most risk rating systems identify common characteristics of stands where epidemics occur:

1. Climate.
2. Average tree diameter 8 inches or more.
3. Average age 80 years or more.
4. Twenty-five percent or more trees 8 inches or more diameter at breast height (d.b.h.) with phloem thickness 0.11 inch or more.

Closeup of passive barrier trap.

Cole says when a stand has these characteristics, land managers, if they plan to let the trees continue to grow, should monitor the stand frequently for signs of beetle activity and be prepared to harvest immediately.

In 1977, Entomologists Gene Amman, Intermountain Station; Mark McGregor, Northern Region; Donn Cahill, CANUSA (Canada-United States Spruce Budworm Program), Boise, Idaho; and William Klein, Forest Service Methods Application Group (now an assistant professor at Stephen F. Austin College, Nacogdoches, Texas), developed guidelines to determine the risk of beetle infestation and help minimize tree losses. The guidelines, used extensively in the Intermountain and

Examining beetles in an infested ponderosa pine log.

northern Rocky Mountain regions, are based on ecological relationships of the beetle and its host. Stand location and tree diameter and age are used to predict the risk of an infestation. Diameter at breast height is usually obtained in a standard forest cruise and, because phloem and d.b.h. are closely related, d.b.h. can be used as an indicator of phloem thickness and beetle production.

Management alternatives

The almost constant mountain pine beetle pressure on lodgepole pine forests poses perplexing problems for the land manager: (1) setting a maximum acceptable loss level; (2) determining long-term mangement goals to reduce losses; and (3) providing for emergency measures to control infestations that exceed the bounds set by items 1 and 2. Repeated beetle depredations on mature forests disrupt sustained-yield forest management. Repeated killing of the largest trees in stands by beetles has been termed "a silvicultural catastrophe."

So the manager is faced with a balancing act. Because the beetles prefer large diameter lodgepole pines, the manager must decide how much risk to accept to grow large diameters or else be willing to manage for small diameter trees. If the risks of producing large trees are too high, several other management options can be considered, for example, type conversion, shorter rotation, and mixtures of species and age class.

Control methods

Cole and Amman believe that stocking control is the most important consideration in preventing mountain pine beetle epidemics in pure, even-aged lodgepole pine stands. Whether one accepts high stand vigor as a primary objective or as a preventive to beetle outbreaks, stocking control remains the most important management option.

Clearcutting is one of the best techniques to remove mature stands and create conditions favorable to regenerating lodgepole pine. The scientists recommend at least 15 years lead time in planning and executing cutting to control losses from the beetle. They believe most of the recent losses could have been prevented or significantly reduced if clearcutting had been started 20 to 35 years ago. However, neither knowledge of beetle dynamics nor adequate markets for lodgepole pine existed at that time.

The researchers and cooperators have conducted several tests of partial cuts, another control method. This approach was used in 1972 on more than 4,000 acres of land in Colorado administered by the Bureau of Land Management. Another partial cutting took place, in 1974, in the West Yellowstone area of Montana. According to Cole, the results are very encouraging. Tree losses have been far less in the partially-cut areas than in the unharvested blocks.

Another alternative is available to the land manager concerned with the mountain pine beetles: do nothing. This alternative, considered a viable one, has long been National Park policy. Cole and Amman caution, however, that this option is becomming increasingly untenable in some areas. Beetles from epidemics migrate to surrounding lands managed for timber products or other resources. There they cut a swath, killing large numbers of trees.

Chemical control is a holding action at best. The researchers say the

effects of such control measures are unpredictable, and the beetles will no doubt reinfest the stand because stand conditions, the cause of the outbreak in the first place, have not been changed. Thus they call chemical control a "precarious choice of action." The scientists do not, however, recommend leaving important trees to the mercy of the bugs.

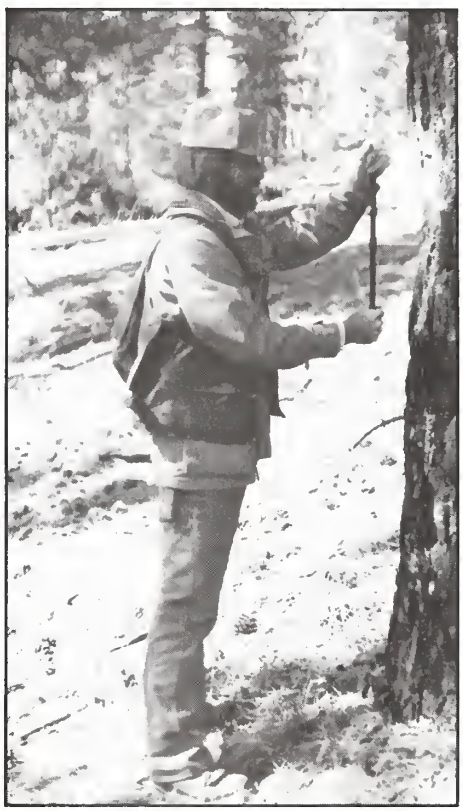
Amman says, "In campgrounds and summer home areas, where there are high-value trees, we recommend preventive spraying of the main stem of the individual tree. It might be expensive, but it is probably worth it to the campground manager or homeowner to save those trees."

Natural enemies of the beetle—woodpeckers and some insects—become more numerous when beetle populations are high. Even though woodpeckers consume large numbers of beetles and cause the death of many more from desiccation when the birds open the bark, studies have shown that during epidemics, woodpeckers have little effect on beetle production. During endemic or normal periods, however,they may play an important role in controlling beetle populations.

Testing the findings

A 1,900-acre site on the Shoshone National Forest in Wyoming is one of several demonstration areas where researchers and managers are testing the recommendations for ways to prevent losses to the beetle before an epidemic cycle begins.

Walter Cole, Donn Cahill, and Gene Lessard, Rocky Mountain Region entomologist, selected the site in the Wind River Drainage for its size and location. In addition, the lodgepole pine trees in most of the stands were 150 to 200 years old and



Obtaining an increment core from ponderosa pine killed by the mountain pine beetle.

Researchers use specially designed traps to catch flying mountain pine beetles in a thinned lodgepole stand on the Gallatin National Forest, Montana.

contained beetles. Younger stands are dominated by lodgepole pine and have a manageable pole and small-size sawtimber component.

The scientists used three general harvesting prescriptions in 37 cutting units: (1) cutting levels based on tree diameters; (2) leave-tree cuts (100 trees per acre); and (3) clearcuts. Check blocks were left untouched. Harvesting begin in January 1979 and was completed in February 1981, well before the 1981 beetle flight.

In each case, the primary purpose was to change stand conditions, either by removing the food supply (thick phloem) of the beetle or increasing growing space for remaining trees. Other criteria were also considered: scenic qualities, wildlife needs, and retention of adequate forest cover to promote natural regeneration.

The trend for the 3 years (2 years before the cut was completed and 1 year after completed cuts) is rather dramatic. In all cutting blocks the number of trees infested by the beetle dropped considerably after harvesting. The check block continued to lose trees at about the same rate.

Some questions

What is the future of these stands on the Shoshone National Forest?

A lodgepole pine stand that has been thinned to minimize losses to the mountain pine beetle.

The harvest levels reduced the current amount of loss, but will the beetle resume killing trees at the same rate as before harvesting? Has a change been induced in the course of an infestation?

To simulate answers to these questions, the entomologists have turned to a new computer system, the Rate of Loss Model, developed by Cole and McGregor. Using the system, managers can obtain estimates of the amount of tree and volume loss per year and the longevity of the infestation. Used in conjunction with FORPLAN (the computer program used in forest planning), the model shows which stands should be harvested immediately and which ones can be left some years before they become highly susceptible to beetle epidemics.

For the Shoshone site, the model projected that the infestation within the check areas should have peaked in 1981, with 46.9 trees killed per acre, subside to 1.1 trees per acre by 1989, and decrease to 0.02 tree per acre by 1993. On the 100-leave-tree cut, the projection extended the predicted life of the infestation to the year 2012, with peak tree loss of only 1.5 trees per acres in 1993. According to these predictions, the 100-leave-tree cut would greatly reduce tree loss from the mountain pine beetle.

If the results from the Shoshone site prove to be similar in the other demonstration areas, and the scientists believe they will, land managers have a valuable new tool in the battle against the mountain pine beetle. The Rate of Loss Model, coupled with the wealth of information garnered since studies began over 20 years ago, gives land managers a better than even chance of seeing productive lodgepole pine stands inhabited by a peaceful beetle population.

Walter Cole and Gene Amman have summarized much of the information on the mountain pine beetle in lodgepole pine forests in the reports listed below. Published by the Intermountain Station, they include discussions of risk rating systems, management alternatives, and control methods.

Mountain Pine Beetle Dynamics in Lodgepole Pine Forests, Part I: Course of an Infestation, General Technical Report INT-89, by Walter E. Cole and Gene D. Amman. Includes beetle impact on the lodgepole pine stand, how the beetle "moves through" the stand, expected timber mortality, and management alternatives.

Mountain Pine Beetle Dynamics in Lodgepole Pine Forests, Part II: Population Dynamics, General Technical Report INT-145, by Gene D. Amman and Walter E. Cole. Includes bionomics, analyses of mortality factors, entomological relationships, and the "inner workings" of a mountain pine beetle population.

Mountain Pine Beetle Dynamics in Lodgepole Pine Forests, Part III: Sampling and Modeling of Mountain Pine Beetle Populations, General Technical Report INT, to be issued in 1984, by Walter E. Cole, Gene D. Amman, and Chester E. Jensen. Includes sampling methods and models for beetle and tree populations.

New publications

1984 lodgepole pine symposium announced

More than 40 invited speakers from the United States, Canada, Sweden, and the United Kingdom will present information on lodgepole pine management and utilization at a symposium in May 1984.

Sponsors of the symposium are: Intermountain Forest and Range Experiment Station, Washington State University, the University of British Columbia, and Canadian forestry and research organizations.

Because of the difficulties in travel authorization for government employees to cross the U.S./Canada border, the symposium will be presented twice, with all papers presented at both sessions:

1. May 8-10, 1984. Ridpath Hotel, Spokane, Washington, USA.
2. May 14-16, 1984. University of British Columbia, Vancouver, B.C.

Poster sessions for volunteer presentations of current research and new ideas are planned for the Spokane and Vancouver programs.

For further information on U.S. and Canadian locations contact:

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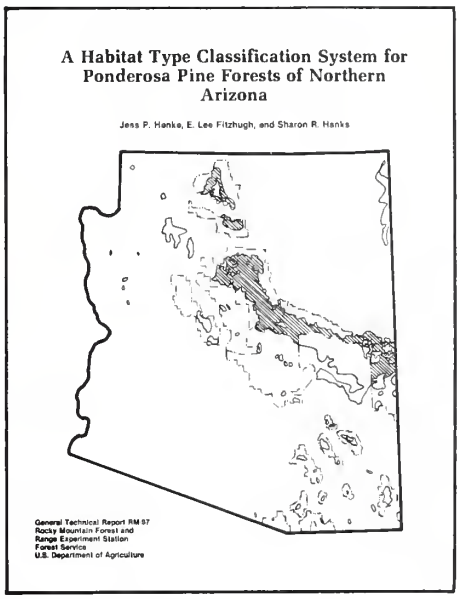


New classification system developed

The Rocky Mountain Station has just published a report describing the potential of land to support plant associations in the ponderosa pine forests of northern Arizona.

The publication, titled *A Habitat Type Classification System for Ponderosa Pine Forests of Northern Arizona,* describes methods used in the study, and the different habitat type and community type descriptions that support this tree species in northern Arizona.

This information which includes management implications, should help improve one's understanding and use of forested lands in the Southwest.

For a copy of the paper, write the Rocky Mountain Station and request General Technical Report RM-97, by Jess P. Hanks, E. Lee Fitzhugh, and Sharon R. Hanks.

Looking out for cavity nesting birds

Traditionally, snags have been a bane on the forest landscape. In the West, they generally were considered prime targets for firestarting lightening strikes. Today's current demand for dead wood for paper, particle board, house logs, and firewood makes it both possible and practical for a forest manager to completely remove all snags from many forest stands.

Total snag removal, however, could eliminate most cavity-nesting birds from affected stands. These days, most foresters choose to maintain or increase present populations of cavity-nesting birds in the forests they manage. This choice reflects an appreciation of the insect-feeding habits of these birds as well as an awareness that the birds add life to the forest and are fun to watch.

The Intermountain Station has published a report that provides an index to the contents of more than 1,700 references pertaining to cavity-nesting birds. *A Cavity-Nesting Bird Bibliography—Including Related Titles on Forest Snags, Fire, Insects, Disease, and Decay,* General Technical Report INT-140, is organized in three parts: the numbered list of titles, the subject matter indexes, and the geographic index. The bibliography resulted from a study of the ecological relationships between cavity-nesting birds, forest snags, and decay in western Montana larch-fir forests.

Authors of the report are William C. Fischer, research forester for the Intermountain Station's Fire Effects and Use Research and Development Program, Northern Forest Fire Laboratory, Missoula, Montana, and

B. Riley McClelland, an associate professor of forestry at the University of Montana, Missoula.

Copies of the bibliography are available from the Intermountain Station.

Simulating the growth of lodgepole pine

The lodgepole pine of Oregon, long thought of as a scrub tree without value, is growing in importance as a commercial species. A Pacific Northwest Station report now provides forest managers with a growth simulation model of *Pinus contorta* Dougl.

The model simulates "growing" lodgepole pine at different spacing and stand densities to see how these affect tree size, total production, and rotation length. This will provide foresters with a basis for choosing the most desirable alternative for new stands that are replacing the old-growth now being harvested. There are real opportunities to concentrate on trees that will reach usable size, author Walter G. Dahm believes.

This simulation model consists of a package of programs for a Hewlett-Packard 9845A desk-top computer.

Copies of *Growth Simulation Model for Lodgepole Pine in Central Oregon,* Research Paper PNW-302, are available from the PNW Station.

Safety in bear country

What is the most effective way to stop an obviously aggressive bear that has gotten within 15 yards and appears intent on doing bodily harm?

Researchers at the Pacific Northwest Station have evaluated weapons and ammunition commonly used by residents of Alaska where Brown bears are frequently encountered by people working or playing in the outdoors. Large and medium caliber magnum, and large, medium, and small caliber rifles, and handguns and shotguns are discussed in a new report authored by Authors William R. Meehan and John F. Thilenius. They like the .458 magnum rifle the best.

They stress, however, that the experience and preferences of individuals must be considered in choosing a weapon. The difference between weapons alternatives are discussed. The use of rifles is also considered, with recommendations for training people.

The two scientists emphasize that shooting a bear should be a last resort. They discuss the realities of shooting a brown bear, and offer precautions that people can take to avoid contact with them.

Copies of *Safety in Bear Country: Protective Measures and Bullet Performance at Short Range,* General Technical Report PNW-152, are available from the PNW Station.

Reconsidering aspen harvesting

Quaking aspen (populus tremuloides Michx) stands occupy about 4.1 million acres of commercial forest land in the Rocky Mountains, and contain an estimated 7.3 billion board feet of sawtimber.

Because many of these stands are mature or overmature, efforts to harvest them are on the increase.

A new report out of the Rocky Mountain Station suggests that partial cutting, such as selection and shelterwood, may have detrimental effects on the residual trees, and not be a desirable method of harvesting aspen stands. Tree wounds, common with most logging practices, often become infected with canker diseases. In addition, once a stand is opened by logging, increased sunscald and infestations by insects weaken residual trees.

For further information on this research, write the Rocky Mountain Station and request *Effects of Partial Cutting on Diseases, Mortality, and Regeneration of Rocky Mountain Aspen Stands,* Research Paper RM-240, by James W. Walters, Thomas E. Hinds, David W. Johnson, and Jerome Beatty.

Wood fiber in the Rocky Mountain states

Worldwide demand for energy is rising rapidly, with an associated rise in price; predictably, wood only marginally useful for fuel is becoming more appealing. To fully evaluate how much wood might be available for fuel or energy, techniques must be developed to convert conventional summaries of merchantable timber volume to estimates of total wood fiber.

A resource bulletin issued by the Intermountain Station represents a first step in providing fiber estimates of the total forest resource in the Rocky Mountain States: Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico. *Whole Tree Volume Estimates for the Rocky Mountain States,* Resource Bulletin INT-29, by Dwane D. Van Hooser and David C. Chojnacky, describes methods for

converting merchantable volume to weight, and for predicting weights and volumes of wood in tops and limbs. Van Hooser is project leader, and David Chojnacky and associate mensurationist, of the Intermountain Station's Forest Survey Research Work Unit, headquartered in Ogden, Utah.

Information in the bulletin can be used to make various approximations. For example, summaries presented in appendix B can be used as estimates of the weight of the standing trees by species and diameter and by ownership and timber type for each State in the Rocky Mountain Region.

The data base for this study was the resource summaries developed for the latest Department of Agriculture timber appraisal (1982). It includes numbers of trees and bole wood volume to a 4-inch top summarized by State, ownership, species, and ownership class.

Copies of the bulletin are available from the Intermountain Station.

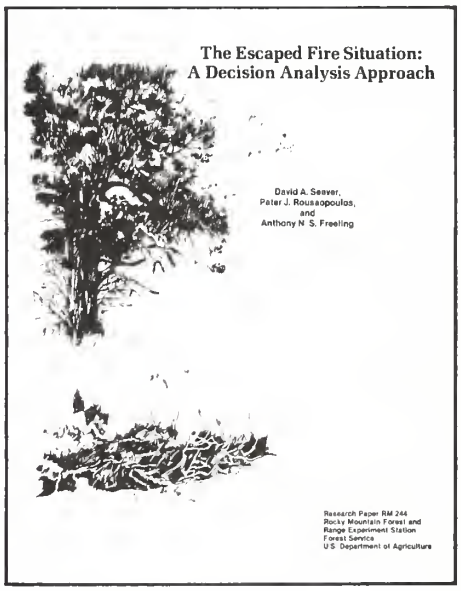
Effects of sealed bidding on dependent communities

The National Forest Management Act of 1976 required the use of sealed bidding on all timber sales except when the Secretary of Agriculture determined otherwise. What were the effects of this requirement on timber dependent communities?

A report by the Pacific Northwest Station includes case studies conducted in Medford and Grant County, Oregon, and the Nez Perce National Forest area in Idaho that analyze whether there was an effect of timber prices and flow when there was a change from oral to sealed bidding. In general, these studies found that bidding did not become disruptive nor were economic factors changed very much. But the studies did indicate that the economies of dependent communities are sensitive, according the report editor Richard W. Haynes.

The issue of sealed bidding is now quiet because Congress changed the Act of 1976 to no longer mandate its use. But the study editor believes the issue is not resolved.

Copies of *Competition for National Forest Timber: Effects on Timber-Dependent Communities,* General Technical Report PNW-148, are available from the PNW Station.



An escaped fire...what now?

A new report from the Rocky Mountain Station describes a case study to determine the basic structure of escaped fire strategy decisions in terms of appropriate decision criteria, reasonable alternatives, and critical information uncertainties.

Although an "escaped fire policy" has been in effect since 1978, current direction for the process is often too time-consuming and cumbersome for use in real-time emergency decisionmaking.

The authors investigate the use of concepts and methods of decision analysis to model decisions and to identify crucial aspects of the decisions that need to be addressed explicitly, and aspects that are less crucial, where effort can be saved to improve analytical efficiency. This is not an operational process, but is a research approach to help determine what is important in making escaped fire strategy decisions.

For your copy of the report, write the Rocky Mountain Station and request *The Escaped Fire Situation: A Decision Analysis Approach,* Research Paper RM-244, by David A. Seaver, Peter J. Roussopoulos, and Anthony N.S. Freeling.

Equation tools for fire managers

Size and shape can be important in lots of things; they are particularly so to land managers concerned with wildland fires. When such a fire occurs, the fire management staff needs to know its expected size and shape so the impact on land resources can be assessed and suppression forces dispatched.

Recent research has provided ways to predict how far a fire will travel in a given situation, but until now the information could not be used to estimate fire size and shape. Hal Anderson, Intermountain Station researcher, Missoula, Montana,

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analyzed early wildland fire records and wind tunnel research results for data that could be applied to provide such information. His analysis provided the basis for a mathematical approach, using a double ellipse model, to estimate fire size and shape. The equations can be used to calculate the perimeter, fire area, flank and backing fire spread rates, and length to width ratio; and to plot fire shape.

Predicting Wind-Driven Wild Land Fire Size and Shape, Research Paper INT-305, by Hal E. Anderson, documents the development of the procedure. The report also reviews observations and methods of the assessment and provides examples that will aid in testing the procedure. Illustrations show how the model can be used to confirm other fire behavior models.

The Intermountain Station has copies of the report.

The role of rocks in slope stability

Not all rocks are equal—some are strong, some are weak. The difference is significant to forest engineers who build roads in the batholith zones of Idaho or other western States.

Subsurface bedrock properties play an important role in determining slope stability in a batholith area. Properties such as degree of weathering are difficult to identify, however, before roads are constructed. Rocks that have weathered or altered enough to contain sufficient clay to exhibit plastic properties are particularly susceptible to mass failure following disturbances such as roadbuilding.

James L. Clayton, soil scientist at the Intermountain Station's Forestry Sciences Laboratory, Boise, Idaho, directed a study of subsurface rock in the Idaho batholith. This batholith outcrops across Idaho more or less continuously for about 250 miles in a north-south direction, and 80 miles east-west. Eleven National Forests cover more than 80 percent of the batholith lands.

Researchers evaluated the usefulness of seismic, resistivity, and vegetation surveys to predict subsurface strength of granitic rock. The surveys were conducted along the centerline of a road scheduled for construction on the Silver Creek watershed of the Boise National Forest. Immediately after the road was constructed, the scientists classified the weathering and fracturing characteristics of all exposed bedrock.

Results of the study show that geophysical techniques can be used successfully to predict zones of highly weathered rock. Eleven of twelve zones identified as highly weathered after the road was constructed had been predicted to be so by one or more of the preconstruction surveys.

Clayton says, "Using such surveys can efficiently narrow the number of sites requiring additional surface exploration or drilling for drainage locations."

The Intermountain Station has copies of *Evaluating Slope Stability Prior to Road Construction,* Research Paper INT-307, by James L. Clayton.

Ownership of private timberlands in western Oregon

The demand for western redcedar outstrips forest managers' abilities to replenish the forest with this high quality timber. To encourage improved management of this species, the Pacific Northwest Station has published a literature review of existing knowledge about it.

A native of the Pacific Northwest and British Columbia, western redcedar today is grown in many parts of the world. This literature review summarizes studies made in England, Denmark, France, Germany, Russia, Norway, Holland, Poland, Italy, Czechoslovakia, Ireland, Austria, the United States, Canada, Japan, New Zealand, and Israel.

The review includes comprehensive information about the occurrence and abundance of redcedar, its associated plant species, morphology, anatomy and composition, products, medical aspects, insects and disease, birds and mammals, genetics, horticulture, physiology and ecology, mensuration and silviculture, and concludes with recommendations for management.

Copies of *Western Redcedar—A Literature Review,* General Technical Report PNW-150, by Don Minore are available from the PNW Station.

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